

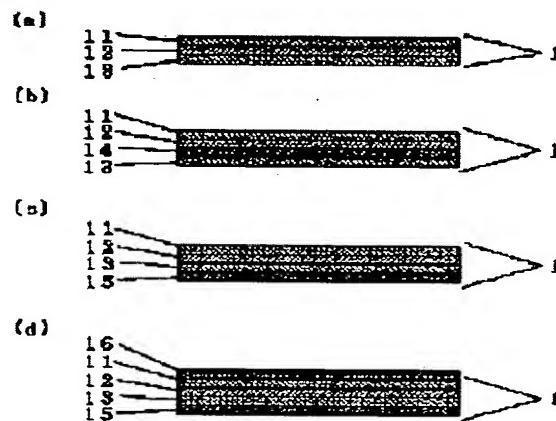
CIRCULARLY POLARIZED LIGHT-SEPARATING LAYER, OPTICAL ELEMENT, POLARIZED LIGHT SOURCE DEVICE, AND LIQUID CRYSTAL DISPLAY DEVICE

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Abstract of JP10321025

PROBLEM TO BE SOLVED: To reduce aslant transmitted elliptically polarized light, without damaging a transmitted circularly polarized light characteristic of vertically incident light contributing to the front brightness, and convert the elliptically polarized light into light capable of contributing to increase in the front brightness by arranging a medium for varying a polarized light state between base layers consisting of a cholesteric liquid crystal layer, in which the difference in the center wave length of reflecting light is within a specified value. **SOLUTION:** As base layers 11, 13 consisting of a cholesteric liquid crystal layer, a cholesteric liquid crystal layer in which difference in the center wave length of reflecting light is within 20 nm is used. Media 12, 14 for varying a polarized light state are arranged between the base layers 11, 13, and superimposed. Thereby, part of light transmitted aslant through one base layer is totally reflected through the other base layer. The cholesteric liquid crystal layer, especially the cholesteric liquid crystal layer in which the center wave length of reflecting light differs 80 nm or more from that of at least one base layer is suitable.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]**[0001]**

[Field of the Invention] This invention relates to the optical element using the circular polarization of light detached core and it which are excellent in efficiency for light utilization, and can form the polarization light equipment of high brightness, and the liquid crystal display of a right check by looking.

[0002]

[Background of the Invention] Conventionally, the polarization light source using the circular polarization of light detached core which consists of a cholesteric-liquid-crystal layer divided into the circular polarization of light of right and left of the natural light through reflection and transparency was known (JP,59-127019,A, JP,61-122626,A, JP,63-121821,A, JP,3-45906,A, JP,6-324333,A, JP,7-35925,A, JP,7-36025,A JP,7-36032,A).

[0003] However, although the light which carried out perpendicular (transverse plane) incidence to the circular polarization of light detached core was penetrated as the circular polarization of light of the method of Uichi Hidari, the light which carried out oblique incidence was penetrated as elliptically polarized light, in order that this might maintain a elliptically-polarized-light condition, without becoming the linearly polarized light like the circular polarization of light through a quarter-wave length plate, it contained the component absorbed by the polarizing plate and the scarce trouble was in efficiency for light utilization.

[0004] Moreover, it had the trouble which carries out perpendicular outgoing radiation and does not contribute to improvement in transverse-plane brightness effective in reservation of right checks by looking, such as a liquid crystal display, from a circular polarization of light detached core while it turned into light in which visibility is reduced as color change by viewing-angle change, when it applied to a liquid crystal display etc., in order that the elliptically polarized light which carried out the slanting transparency of the circular polarization of light detached core might receive color change.

[0005]

[The technical technical problem of invention] Without injuring the transparency circular polarization of light property of the vertical-incidence light which contributes to transverse-plane brightness, this invention reduces the elliptically polarized light of slanting transparency, and makes a technical problem development of the circular polarization of light detached core which can change the elliptically polarized light into the light which can contribute to improvement in transverse-plane brightness.

[0006]

[Means for Solving the Problem] The circular polarization of light detached core to which, as for this invention, a difference of the main wavelength of the reflected light is characterized by having arranged the medium to which a polarization condition is changed between the base layers which consist of a less than 20nm cholesteric-liquid-crystal layer is offered.

[0007]

[Effect of the Invention] According to this invention, vertical-incidence light carries out the perpendicular

transparency of each cholesteric-liquid-crystal layer of superposition as the predetermined circular polarization of light, and contributes to improvement in transverse-plane brightness. In case conversion of a polarization property is received, the hand of cut of a part of the polarization is reversed and oblique incidence of the elliptically polarized light which carried out the slanting transparency of the base layer of one side, and carried out oblique incidence to the medium to which a polarization condition is changed on the other hand is carried out to the following base layer by penetrating the medium, total reflection of it is carried out, and transparency of a circular polarization of light detached core is interrupted. Without injuring the transparency circular polarization of light property of the vertical-incidence light which contributes to transverse-plane brightness the aforementioned result, when it applies to a liquid crystal display etc., the elliptically polarized light of the slanting transparency to which visibility is reduced as color change by viewing-angle change can be reduced.

[0008] On the other hand, in case the polarization by which total reflection was carried out with the above re-penetrates the medium to which a polarization condition is changed as a return light, a polarization property is reversed again, penetrates the base layer by the side of incidence, and carries out outgoing radiation of it from a circular polarization of light detached core. By making it reflect through a reflecting layer, carrying out incidence to a circular polarization of light detached core again, and making it spread through a diffusion layer in the meantime, this outgoing radiation light can make that part able to put to a circular polarization of light detached core perpendicular ON, and can be taken out as a light of the direction of a transverse plane. Consequently, interrupting transparency by the total reflection according the elliptically polarized light which carried out the slanting transparency of one base layer to the base layer of another side, the total reflection light is reused, from a circular polarization of light detached core, the light of the direction of a transverse plane effective in a right check by looking of a liquid crystal display etc. is obtained, and transverse-plane brightness can be raised. The liquid crystal display which can form the polarization light equipment which is excellent in efficiency for light utilization using this circular polarization of light detached core, and which is excellent in especially transverse-plane brightness, and is bright and is excellent in visibility combining a quarter-wave length plate, a polarizing plate, etc. can be obtained the aforementioned result.

[0009]

[Embodiment of the Invention] The circular polarization of light detached core of this invention consists of what has arranged the medium to which a polarization condition is changed between the base layers which a difference of the main wavelength of the reflected light becomes from a less than 20nm cholesteric-liquid-crystal layer. The example was shown in drawing 1 (a) – (d). 1 is a circular polarization of light detached core, and a base layer, the medium to which 11 and 13 change 12 and 14 change a polarization condition, and 15 and 16 are the cholesteric-liquid-crystal layers of outside arrangement.

[0010] As a cholesteric-liquid-crystal layer, the proper thing which divides the natural light into the circular polarization of light on either side as the transmitted light and the reflected light by GURANJAN orientation can be used. Incidentally as the example, the sheet which has the layer which has a cholesteric-liquid-crystal phase, and the layer which consists of a liquid crystal polymer which presents a cholesteric phase above all, the sheet which developed the layer concerned on the glass plate etc., or the film which consists of a liquid crystal polymer which presents a cholesteric phase is raised. Therefore, the cholesteric-liquid-crystal layer may be superimposed in the condition of having been supported on the support base material if needed.

[0011] As for a cholesteric-liquid-crystal layer, in the above, it is desirable to carry out orientation to homogeneity as much as possible. The cholesteric-liquid-crystal layer of homogeneity orientation offers the reflected light without dispersion, is advantageous to expansion of the angle of visibility of a liquid crystal display etc., and suitable for formation of the direct viewing type liquid crystal display by which direct observation is especially carried out also from across.

[0012] The circular polarization of light detached core by this invention can be formed when a difference of the main wavelength of the reflected light arranges and superimposes the medium to which a polarization condition is changed between the base layers which consist of a less than 20nm cholesteric-

liquid-crystal layer. It becomes possible to carry out total reflection of a part of light which carried out the slanting transparency of one base layer through the base layer of another side by this. Less than 15nm especially of less than 10nm of differences of the main wavelength of the reflected light between base layers more desirable than points, such as the achievement nature of the total reflection, is less than 5nm above all. in addition, the base layer relation with which it will be satisfied of total reflection conditions if said difference of the main wavelength of the reflected light carried out exceeds 20nm -- forming -- being hard -- it becomes easy to penetrate oblique-incidence light.

[0013] As a medium to which the polarization condition arranged between base layers is changed, the proper thing in which a polarization condition is changed and it deals can be used, for example like phase contrast plates, such as a quarter-wave length plate and 1/2 wavelength plate. A cholesteric-liquid-crystal layer, especially the cholesteric-liquid-crystal layer to which 80nm or more of main wavelength of the reflected light is different from it of one [at least] base layer are more desirable than the point of expanding the wavelength region of the transmitted light above all etc. Namely, although a limitation is located in the wavelength region which shows selective reflection nature (circular dichroism) and the limitation also has usually the case of the large range which reaches about 100nm wavelength region in the cholesteric-liquid-crystal layer of a monolayer Since it is less than the whole region of the light desired when applying to a liquid crystal display etc. also in the wavelength range The wavelength region which is made to superimpose the cholesteric-liquid-crystal layer from which selective reflection nature (reflected wave length region) differs, and shows circular dichroism is made to expand, and a cholesteric-liquid-crystal layer can use preferably from the whole region thru/or the point which forms the whole region into a reflected wave length region as much as possible of a light region.

[0014] The medium to which the polarization condition arranged between base layers is changed may be one layer or more than two-layer. When arranging the cholesteric-liquid-crystal layer more than two-layer as a medium to which a polarization condition is changed between base layers, it is more desirable than the aforementioned point to consider as a reflected wave length region and the combination of the cholesteric-liquid-crystal layer from which the main wavelength of the reflected light differs above all. In addition, between base layers, proper light transmission layers other than the medium to which a polarization condition is changed may be arranged, and the light transmission layer may be optical stratum functionale.

[0015] Moreover, what shows 1 / 2 wavelength plate functions to the slanting transmitted light is more desirable than the point to which total reflection of a part of light which carried out the slanting transparency of one base layer is carried out through the base layer of another side as a medium to which a polarization condition is changed. These 1 / 2 wavelength plate functions may be attained by a part or the whole of the medium to which the polarization condition arranged between base layers is changed. That is, when the number of the media to which a polarization condition is changed is one, it is called for that one of them shows 1 / 2 wavelength plate functions, but when the medium to which a polarization condition is changed is more than two-layer, more than two-layer [the / one layer or two-layer] may show 1 / 2 wavelength plate functions, respectively, and it may show 1 / 2 wavelength plate functions above [whole] two-layer.

[0016] In addition, the method which arranges the cholesteric-liquid-crystal layers 15 and 16 to which 80nm or more of main wavelength of the reflected light is different from it of a base layer on the outside of the base layers 11 and 13 can also attain expansion of the reflected wave length region by superposition of the above-mentioned cholesteric-liquid-crystal layer like instantiation to drawing 1 (c) and (d). In that case, a cholesteric-liquid-crystal layer can superimpose one layer or more than two-layer on both base both [one side or]. And also in this case, when a total of a two or more-layer cholesteric-liquid-crystal layer is superimposed on both base both [one side or], it is desirable a reflected wave length region and to consider as combination above all, although the main wavelength of the reflected light differs.

[0017] As for the cholesteric-liquid-crystal layer which superimposes in the above, it is desirable than the point which increases the quantity of the polarization in the condition that it can prevent and use

that it will be in a polarization condition which arranges the phase condition of the circular polarization of light reflected on each class, and is different in each wavelength region to use in the combination of what reflect the circular polarization of light of the same direction, and in order to attain total reflection, it needs to use in the combination of what reflect the circular polarization of light of the same direction between base layers. Moreover, a cholesteric-liquid-crystal layer is more desirable than the point that being superimposed in order of the wavelength based on the main wavelength of the reflected light except for one base layer controls the wavelength shift at the time of a large angle of visibility etc.

[0018] A proper thing may be used for cholesteric liquid crystal, and there is especially no limitation in it. Therefore, various things, such as a principal chain mold with which the straight-line-like atomic group (meso gene) of the conjugate property which gives a liquid crystal stacking tendency was introduced into the principal chain and side chain of a polymer, and a side-chain mold, can be used. The wavelength region of selective reflection becomes large and the larger cholesteric-liquid-crystal molecule of phase contrast can be used more preferably than points, such as allowances over the wavelength shift at the time of a large angle of visibility. Moreover, rather than weight or the point of ******, a liquid crystal polymer can use preferably. Furthermore, as the liquid crystal polymer, that whose glass transition temperature is 30–150 degrees C can use preferably from points, such as handling nature and the stability of the orientation in operating temperature.

[0019] Incidentally, as an example of the liquid crystal polymer of the above mentioned principal chain mold, it has the structure which combined the meso gene radical which minds the spacer section which gives flexibility if needed, and consists of a Para permutation ring compound etc., for example, polymers, such as a polyester system, a polyamide system, a polycarbonate system, and a polyester imide system, are raised.

[0020] Moreover, a thing, a nematic system liquid crystal polymer of low-molecular chiral agent content, a liquid crystal polymer of chiral component installation, a mixed liquid crystal polymer of a nematic system and a cholesteric system, etc. which have the low-molecular-liquid-crystal compound (meso gene section) which makes polyacrylate, polymethacrylate, a polysiloxane, poly malonate, etc. a principal chain frame, minds the spacer section which consists of an atomic group of conjugate property as a side chain as an example of the liquid crystal polymer of a side-chain mold if needed, and consists of a Para permutation ring compound etc. are raised.

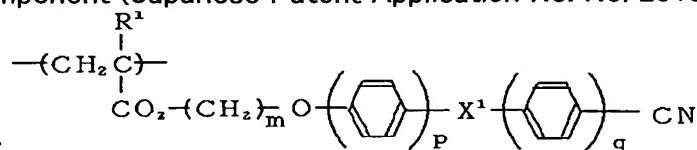
[0021] Like the above, it can consider as the thing of a cholesteric stacking tendency with the method which introduces the proper chiral component which consists of a compound which has asymmetrical carbon also in what has the Para permutation ring compound which gives the nematic stacking tendency which consists of the Para permutation aromatic-series unit, the Para permutation cyclohexyl ring unit, etc. like for example, an azomethine form, an azo form, an AZOKISHI form and an ester form, a biphenyl form and a phenylcyclohexane form, and a bicyclo hexane form, a low-molecular chiral agent, etc. (JP,55-21479,A, U.S. Pat. No. 5332522, etc.). In addition, a cyano group, the alkyl group, alkoxy group of the end substituent in the para position in the Para permutation ring compound, etc. may be proper.

[0022] Moreover, as the spacer section, for example, polymethylene chain-(CH₂)_n, polyoxymethylene chain-(CH₂CH₂O)_m, etc. which show flexibility are raised. the chemical structure of the meso gene section etc. determines suitably the number of cycles of the structural unit which forms the spacer section -- having -- general -- the case of a polymethylene chain -- n -- 0-20, and the case where they are 2-12, and a polyoxymethylene chain above all -- m -- 0-10 -- it is 1-3 above all.

[0023] In addition, the proper method according to the usual polymer composition to which copolymerization for example, of the component monomer is carried out with a radical polymerization method, a cationic polymerization method, an anionic polymerization method, etc. can perform preparation of the above-mentioned principal chain mold liquid crystal polymer. Moreover, the monomer addition polymerization method which polymerizes the monomer to which preparation of a side-chain mold liquid crystal polymer also introduced the meso gene radical into the monomer for vinyl system principal chain formation like the ester of an acrylic acid or a methacrylic acid through the spacer radical if needed by a radical polymerization method etc., The method which carries out the addition reaction of the vinyl

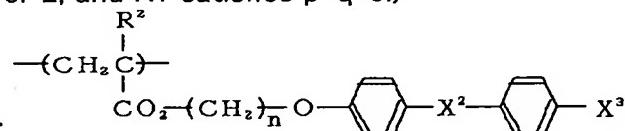
permutation meso gene monomer to the bottom of existence of a platinum system catalyst through Si-H association of polyoxy methyl silylene. The method which introduces a meso gene radical by the esterification reaction using a correlation migration catalyst through the functional group given to the principal chain polymer, A method with the proper method which carries out a polycondensation reaction can perform the monomer which introduced the meso gene radical into some malonic acids through the spacer radical if needed, and diol.

[0024] In the above Membrane formation nature and the good GURANJAN stacking tendency of a mono-domain condition, The short-time nature of orientation processing, the stable stability to a vitreous state, the controllability of the spiral pitch of a cholesteric phase, The liquid crystal polymer which can be used more preferably than points, such as the plasticity of the circular polarization of light detached core which orientation conditions, such as a pitch, cannot change easily due to operating temperature, and is lightly [it is thin and] excellent in endurance or preservation stability the copolymer which uses as a component the monomeric unit expressed with the following general formula (a), and the monomeric unit expressed with a general formula (b) — above all with 60 – 95 % of the weight of monomeric units of a general formula (a) Let the copolymer which consists of 40 – 5 % of the weight of monomeric units of a general formula (b) be a component (Japanese Patent Application No. No. 251818 [seven to]).



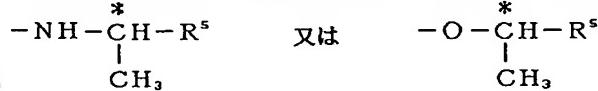
[0025] General formula (a) :

(However, the integer of 1–6 and X1 are two COs or an OCO radical, and hydrogen or a methyl group, and m are p and q1, or 2, and R1 satisfies p+q=3.)

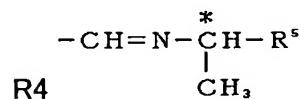


General formula (b) :

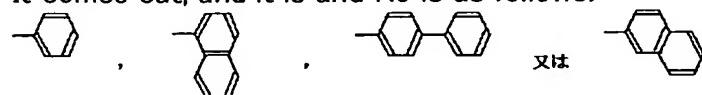
R2 [however,] — hydrogen or a methyl group, and n — the integer of 1–6, and X2 — two COs or an



OCO radical, and X3 –CO–R3 or –R4 — it is — the R3



It comes out, and it is and R5 is as follows.



[0026] The acrylic monomer which can form the monomeric unit expressed with the aforementioned general formula (a) and a general formula (b) is compoundable by the proper approach. As the example, first ethylene chlorohydrin and 4-hydroxybenzoic acid After carrying out heating reflux in an alkali water solution by making potassium iodide into a catalyst and obtaining hydroxycarboxylic acid, Carry out dehydration of it to an acrylic acid or a methacrylic acid, and it considers as acrylate (meta). By esterifying the (meta) acrylate under existence of DCC (dicyclohexylcarbodiimide) and DMAP (dimethylamino pyridine) by the 4-cyano-4'-hydroxy biphenyl, the method of obtaining the monomer belonging to a general formula (a) raises, and it is ****.

[0027] moreover, as a synthetic example of the acrylic monomer belonging to a general formula (b) After carrying out the heating reflux of hydroxyalkyl halide and the 4-hydroxybenzoic acid in an alkali water solution by making potassium iodide into a catalyst first and obtaining hydroxycarboxylic acid, Dehydration of it is carried out to an acrylic acid or a methacrylic acid. As acrylate (meta) the acrylate (meta) of Perilla frutescens (L.) Britton var. crispa (Thunb.) Decne. The approach of esterifying under existence of DCC and DMAP, the approach of esterifying the (meta) acrylate under existence of DCC and DMAP after the aforementioned dehydration with the phenol which has an asymmetrical carbon radical in the 4th place, etc. are raised with the phenol which has CO radical of R three-set content in the 4th place.

[0028] Therefore, other monomers belonging to an aforementioned general formula (a) and an aforementioned general formula (b) are compoundable according to the above using the proper raw material which has the introductory target radical. In addition, the phenol which has CO radical of R three-set content in the 4th aforementioned place For example, make methyl chloroformate and 4-hydroxybenzoic acid react in an alkali water solution first, and it considers as a carboxylic acid. After making it into acid chloride by oxalyl chloride, by the approach of making it reacting with H-R3 in a pyridine/tetrahydrofuran, introducing R3 set, processing it with aqueous ammonia subsequently, and removing a protective group etc. Moreover, the phenol which has an asymmetrical carbon radical in the 4th place can be obtained by the approach of carrying out azeotropy dehydration of for example, a 4-hydroxy benzaldehyde and the (S)-(-)-1-phenyl ethylamine in toluene etc.

[0029] The above-mentioned copolymer can change the spiral pitch of cholesteric liquid crystal by changing the content of the monomeric unit expressed with the general formula (b). Therefore, the wavelength which shows circular dichroism by control of the content of the monomeric unit expressed with a general formula (b) can be adjusted, and the optical element which shows circular dichroism to the light of a light region can also be obtained easily.

[0030] Formation of the cholesteric-liquid-crystal layer by the liquid crystal polymer can be performed by the approach according to the conventional orientation processing. Incidentally as the example, on a support base material, polyimide and polyvinyl alcohol, The orientation film which formed film, such as polyester, polyarylate and polyamidoimide, and polyether imide, and carried out rubbing processing with the rayon cloth etc., A liquid crystal polymer is developed on the proper orientation film which consists of a method vacuum evaporationo layer of slanting of SiO, or orientation film by extension processing. Or more than glass transition temperature It heats under to isotropic phase transition temperature, after the liquid crystal polymer molecule has carried out GURANJAN orientation, it cools under to glass transition temperature, and it considers as a vitreous state, and the approach of forming the frozen layer by which the orientation concerned was fixed etc. is raised.

[0031] As the aforementioned support base material, proper things, such as a monolayer which consists of plastics like triacetyl cellulose, polyvinyl alcohol and polyimide, polyarylate and polyester, a polycarbonate, polysulfone and polyether sulphone, amorphous polyolefine and a denaturation acrylic polymer, and epoxy system resin, for example, a laminated film, or a glass plate, can be used. Plastic film is more desirable than points, such as thin-shape-izing, and a small thing has the phase contrast as much as possible more desirable than points, such as improvement in the use effectiveness of the light by prevention of change of a polarization condition, by the birefringence.

[0032] Expansion of a liquid crystal polymer can carry out thin layer expansion of the solution by the solvent of a liquid crystal polymer by proper approaches, such as a spin coat method, the roll coat method, the flow coat method and the printing method, a dip coating method and the flow casting forming-membranes method, the bar coat method, and gravure, and can be performed by the approach of carrying out desiccation processing of it if needed etc. As the aforementioned solvent, proper things, such as a methylene chloride, a cyclohexanone and a trichloroethylene, tetrachloroethane and N-methyl pyrrolidone, and a tetrahydrofuran, can be used, for example.

[0033] Moreover, the heating melt of a liquid crystal polymer and the heating melt in the condition of presenting an isotropic phase preferably can be developed according to the above, and the approach

which does not use solvents, such as an approach which develops to a thin layer and it is made to solidify further, maintaining the melting temperature if needed, therefore the health nature of work environment, etc. can develop a liquid crystal polymer also by the good approach. In addition, on the occasion of expansion of a liquid crystal polymer, the superposition method of the cholesteric-liquid-crystal layer which minded the orientation film if needed for the purpose of thin-shape-izing etc. can be taken.

[0034] Heat-treatment for carrying out orientation of the expansion layer of a liquid crystal polymer can be performed by heating to the temperature requirement from the glass transition temperature of a liquid crystal polymer to isotropic phase transition temperature, i.e., the temperature requirement where a liquid crystal polymer presents a liquid crystal phase, as described above. Moreover, immobilization of an orientation condition can be performed by cooling under to glass transition temperature, and there is especially no limitation about the cooling condition. Usually, since the aforementioned heat-treatment can be performed at the temperature of 300 degrees C or less, generally a natural-air-cooling method is taken.

[0035] The frozen layer of the liquid crystal polymer formed on the support base material can be used for a circular polarization of light detached core as it is as an one object with a support base material, and can also be used as a circular polarization of light detached core which exfoliates from Japanese lacquer and a support base material, and consists of a film etc. When forming as an one object with the support base material which consists of a film etc., it is more desirable than points, such as the tightness of the change of state of polarization, that phase contrast uses a small support base material as much as possible.

[0036] Especially the thickness of a cholesteric-liquid-crystal layer has 1.5-10 micrometers more desirable than points, such as a size of turbulence of orientation, prevention of a permeability fall, and the wavelength range of selective reflection (reflected wave length region), 1-30 micrometers above all 0.5-50 micrometers. Moreover, it is more desirable than points, such as thin-shape-izing of a circular polarization of light detached core, that 1-50 micrometers of 2-30 micrometers of total thickness of a two-layer cholesteric-liquid-crystal layer are 3-10 micrometers especially above all. When it furthermore has a support base material, it is desirable that 20-200 micrometers of 25-150 micrometers of total thickness including the base material are 30-100 micrometers especially above all. On the occasion of formation of a circular polarization of light detached core, the various additives which become a cholesteric-liquid-crystal layer from a stabilizer, a plasticizer, or metals can be blended if needed.

[0037] The circular polarization of light detached core used in this invention can be made into a gestalt with proper cel gestalt which pinched the cholesteric-liquid-crystal layer which consists for example, of a low-molecular-weight object with transparence base materials, such as glass and a film, gestalt which supported the cholesteric-liquid-crystal layer which consists of a liquid crystal polymer with the transparence base material, gestalt which consists of a liquid crystal polymer film of a cholesteric-liquid-crystal layer, gestalt which superimposed those gestalt objects in proper combination.

[0038] In the aforementioned case, a cholesteric-liquid-crystal layer can also be held according to the reinforcement, operability, etc. with the support base material more than one layer or two-layer. the point of preventing the change of state of polarization in using the support base material more than two-layer etc. -- for example, the film of non-orientation -- even if it carries out orientation, a small thing can use [phase contrast] preferably as much as possible like the small triacetate film of a birefringence etc. Gestalten more desirable than points, such as thin-shape-izing, are the gestalt supported with the transparence base material, a gestalt which consists of a film of a liquid crystal polymer.

[0039] The circular polarization of light detached core by this invention can also be formed in the condition that the cholesteric-liquid-crystal layer used as a base layer is included two or more pairs in the combination from which the main wavelength of the reflected light differs. In addition, use of a liquid crystal polymer is more advantageous to especially superposition of a cholesteric-liquid-crystal layer than points, such as manufacture effectiveness and thin-film-izing. Superposition processing can take proper methods, such as every mere pile and adhesion through adhesives, such as a binder.

[0040] In this invention, one sort of proper optical layers, such as a diffusion layer, a quarter-wave length plate, and a polarizing plate, or two sorts or more can be arranged to a circular polarization of light detached core, and various optical elements can be formed. The example was shown in drawing 2, drawing 3, and drawing 4. For 2, a diffusion layer and 3 are [a quarter-wave length plate and 4] polarizing plates.

[0041] A diffusion layer is prepared in the light source light incidence side of a circular polarization of light detached core in this case for the purpose of course modification of the return light to which it comes to carry out total reflection of the oblique-incidence light in the base layer of a circular polarization of light detached core as described above. Diffusion layers are methods with arbitrary KUREIZU generating method by the method by surface irregularity-ized processing of the formation method of for example, a particle distribution resin layer, sandblasting, chemical etching, etc., mechanical stress, solvent processing, etc., imprint formation method by the metal mold which established predetermined diffusion structure, etc., and can be suitably formed as a spreading layer, a diffusion sheet, etc. to a circular polarization of light detached core.

[0042] Moreover, a diffusion layer equalizes the outgoing radiation light from an optical element, controls light-and-darkness nonuniformity, and when it applies to a liquid crystal cell, it can also arrange it for the purpose of prevention of the check by looking [GIRAGIRA / check by looking] by moire arising in interference with a pixel etc. In this case, it can arrange one layer or more than two-layer in the proper location contiguous to circular polarization of light detached cores and quarter-wave length plates, such as between the quarter-wave length plate formed in the quarter-wave length plate attachment side of a circular polarization of light detached core, or it, or polarizing plates, or a top face of a polarizing plate, a polarizing plate, etc. the vertical-incidence light whose phase contrast of the diffusion layer which can be used more preferably than points, such as the maintenance nature of the polarization condition of the light which carried out outgoing radiation from the circular polarization of light detached core, is the wavelength of 633nm -- based on the incident light of less than 30 incident angles, 30nm or less is a 0-20nm thing above all preferably.

[0043] A quarter-wave length plate functions as a linearly polarized light conversion means, the circular polarization of light which carried out outgoing radiation from the circular polarization of light detached core carries out incidence to a quarter-wave length plate, a phase change is received, the light of the wavelength on which the phase change is equivalent to quarter-wave length is changed into the linearly polarized light, and other wavelength light is changed into elliptically polarized light. The changed elliptically polarized light turns into such flat elliptically polarized light that it is close to the wavelength of the light changed into the aforementioned linearly polarized light. Outgoing radiation of the light in the condition that many linearly polarized light components which may penetrate a polarizing plate are included will be carried out as a result of [this] a quarter-wave length plate.

[0044] Therefore, the quarter-wave length plate 3 is arranged like the example of drawing at the optical outgoing radiation side of the circular polarization of light detached core 1. In addition, when [to require] it is superimposed on the cholesteric-liquid-crystal layer in order of the main wavelength of the reflected light except for one base layer, it is more desirable than points, such as control of the above-mentioned wavelength shift, to make the cholesteric-liquid-crystal layer side of the long wavelength into an optical outgoing radiation side. By changing into a condition with many linearly polarized light components through a quarter-wave length plate, it can consider as the light which is easy to penetrate a polarizing plate like the above. In the case of a liquid crystal display, this polarizing plate functions as the optical layer which prevents the fall of the polarization property generated in change of the angle of visibility to a liquid crystal cell, and maintains display grace, an optical layer which realizes more advanced degree of polarization and attains better display grace.

[0045] That is, in the above, although it is possible to carry out incidence of the outgoing radiation polarization [detached core / circular polarization of light] to a liquid crystal cell as it is, and to attain a display, without using a polarizing plate, since improvement in the display grace described above by minding a polarizing plate etc. can be aimed at, a polarizing plate is used if needed. In that case, it is so

more advantageous that the permeability to a polarizing plate is high than the point of the brightness of a display, and since the permeability becomes so high that many linearly polarized light components of the polarization direction which is in agreement with the polarization shaft (transparency shaft) of a polarizing plate are included, outgoing radiation polarization [detached core / circular polarization of light] is changed into the predetermined linearly polarized light through a linearly polarized light conversion means for the purpose of it.

[0046] While it is equivalent to the phase contrast of quarter-wave length in the circular polarization of light which carried out outgoing radiation and being able to form many linearly polarized lights from a circular polarization of light detached core as a quarter-wave length plate, what can change the light of other wavelength into the flat elliptically polarized light near the linearly polarized light as much as possible [have the major-axis direction in the parallel direction as much as possible with said linearly polarized light, and] is desirable. By using this quarter-wave length plate, it can arrange so that the direction of the linearly polarized light of the outgoing radiation light and the major-axis direction of elliptically polarized light may become parallel as much as possible with the transparency shaft of a polarizing plate, and the light of a condition with many linearly polarized light components which may penetrate a polarizing plate can be obtained.

[0047] A quarter-wave length plate can be formed as a superposition layer of the phase contrast plate more than one layer or two-layer. In the case of the quarter-wave length plate which consists of a phase contrast plate of one layer, a smaller thing can achieve equalization of the polarization condition for every wavelength, and its wavelength dispersion of a birefringence is desirable. On the other hand, superposition-izing of a phase contrast plate is effective in amelioration of the wavelength property in a wavelength region, and the combination may be suitably determined according to a wavelength region etc.

[0048] As a quarter-wave length plate of the monolayer mold which can incidentally be used to the light of a light region more preferably than points, such as wavelength range and conversion efficiency, the phase contrast is a small thing and the thing which gives especially 100–180nm of phase contrast 110–150nm or less above all. Moreover, when considering as the quarter-wave length plate which consists of a phase contrast plate more than two-layer, it is more desirable than points, such as a wavelength property, to consider as combination with the layer which gives the phase contrast 200nm or more which contains the layer which gives 100–180nm phase contrast by odd one or more-layer layers.

[0049] As for the phase contrast plate which forms a quarter-wave length plate, what can form with the proper quality of the material, and gives transparent and uniform phase contrast is desirable. The form birefringence film which comes to carry out extension processing of the film which generally consists of proper plastics, such as a polycarbonate, polysulfone and polyester, polymethylmethacrylate and a polyamide, and poly vinyl alcohol, is used.

[0050] On the quarter-wave length plate 3, a polarizing plate 4 can be formed at above-mentioned drawing 4 if needed like instantiation. The optical element of this gestalt can use the polarizing plate as a polarizing plate by the side of the light source of a liquid crystal cell. Moreover, a polarizing plate may be arranged through a quarter-wave length plate to a circular polarization of light detached core, and forms into the direct linearly polarized light the circular polarization of light which penetrated the circular polarization of light detached core in this case through a polarizing plate.

[0051] Although a proper thing can be used as a polarizing plate, generally what consists of a polarization film is used. As an example of a polarization film, the polyene oriented film like a thing, the dehydration processing object of polyvinyl alcohol, or the demineralization acid-treatment object of a polyvinyl chloride which dichromatic dye, such as iodine, was made to stick to the film of the hydrophilic giant molecule like a polyvinyl alcohol system, a partial formal-ized polyvinyl alcohol system, and an ethylene-vinylacetate copolymer system partial saponification object, and was extended is raised.

[0052] As a polarizing plate attached to a circular polarization of light detached core, the thing of the type containing dichromatic dye is used especially more preferably than points, such as degree of polarization. Although the thickness of a polarization film is 5–80 micrometers usually, it is not limited to

this. The polarizing plate to be used may be what covered one side or both sides of a polarization film with transparent protection layer etc.

[0053] The circular polarization of light detached core and optical element by this invention can be preferably used for formation of polarization light equipment. Formation of polarization light equipment can be performed by arranging a circular polarization of light detached core and an optical element on the light source. In addition, when the light source is arranged at the diffusion layer side in the case of the optical element which has a diffusion layer 2 in an outside surface like drawing 2 and a circular polarization of light detached core has quarter-wave length plate 3 grade like drawing 3 or drawing 4, the light source is arranged at the side which does not have the quarter-wave length plate etc.

[0054] The example of polarization light equipment 5 was shown in drawing 5. This shows the case where a circular polarization of light detached core is used as an optical element, 51 is a light guide plate and 52 is the light source. A light guide plate 51 carries out outgoing radiation of the incident light from the light source 52 arranged on the side face from a top face (circular polarization of light detached core side), functions as the light source 52 in one, and functions as the light source which supplies light to a circular polarization of light detached core.

[0055] According to the aforementioned polarization light equipment 5, the incident light from the light source 52 carries out outgoing radiation from the top face of a light guide plate 51, incidence of the light of the perpendicular direction is carried out to the circular polarization of light detached core 1 arranged to the outgoing radiation side side, the circular polarization of light of the method of Uichi Hidari penetrates, the circular polarization of light of another side is reflected, and re-incidence of it is carried out to a light guide plate 51 as a return light. It is reflected by the reflecting layer 54 at the bottom, and incidence of the light which carried out re-incidence to the light guide plate is again carried out to the circular polarization of light detached core 1, and it is again divided into the transmitted light and the reflected light (third-time incident light).

[0056] On the other hand, incidence also of the return light by which total reflection was carried out is carried out to the reflecting layer 54 under a light guide plate, it is reflected in it in the base layer which carried out oblique incidence to the circular polarization of light detached core 1 and which was described above, and incidence is again carried out to the circular polarization of light detached core 1 through a diffusion layer 2. In that case, a part of re-incident light is changed into the light which can carry out vertical incidence to a circular polarization of light detached core by diffusion through a diffusion layer 2, and it carries out behavior like the light of the above mentioned perpendicular direction. Behavior of the light which remains is again carried out as an oblique-incidence light. Therefore, transverse-plane brightness can be raised, so that there are many rates changed into the light which can carry out vertical incidence to a circular polarization of light detached core by diffusion among the return light of oblique-incidence light.

[0057] As the light source in polarization light equipment, the thing of the light guide plate mold which carries out outgoing radiation of the incident light from the light source arranged on the side face from one side of a vertical side is preferably used from points, such as improvement in efficiency for light utilization, as mentioned above. Although a proper thing can be used as the light guide plate, what consists of a tabular object which generally has the vertical side where either serves as an outgoing radiation side, and the plane of incidence which consists of at least 1 vertical face-to-face side face is used.

[0058] The structure of excelling also in the outgoing radiation effectiveness of the re-incident light which the gestalt of a light guide plate was excellent in the outgoing radiation effectiveness from an outgoing radiation side, and the outgoing radiation light was excellent in the perpendicularity to an outgoing radiation side, and was easy to use it effectively, and minded the circular polarization of light detached core, and having periodically above all prism-like irregularity more detailed than points, such as approximation nature with the direction of initial outgoing radiation of the direction of outgoing radiation, the heights which consist of a long side and a shorter side side, or a crevice is desirable (Japanese Patent Application No. No. 321036 [seven to]). What has the thickness of the side edge section which

furthermore counters plane of incidence thinner than that of plane of incidence, and the thing which is 50% or less of thickness above all are desirable.

[0059] Thin-shape-izing of the opposite side edge section to the aforementioned plane of incidence is advantageous at the point which will carry out incidence to the shorter side side of a prism-like concave convex efficiently by the time the light which carried out incidence from plane of incidence results in the opposite side edge section concerned as a transmission edge, carries out outgoing radiation from an outgoing radiation side through the reflection, and can supply incident light to the purpose side efficiently. Moreover,-izing of the light guide plate can be carried out [lightweight] by considering as this thin shape-sized structure, for example, when a prism-like concave convex is a straight line-like, it can consider as about 75% of weight of the light guide plate of homogeneity thickness.

[0060] The pitch of the heights in a prism-like concave convex or a crevice is so desirable that it is smaller than points, such as control of light-and-darkness nonuniformity, and prevention of moire with a liquid crystal cell, since outgoing radiation light is usually emitted in the shape of a stripe through the heights or crevice. 500 micrometers or less especially of 300 micrometers or less of periods of the desirable heights in consideration of manufacture precision etc. or a crevice are 5-200 micrometers above all.

[0061] A light guide plate can be formed with the proper ingredient which shows it transparency according to the wavelength field of the light source. Incidentally what shows transparency in [wavelength] about 400-700nm is raised in a light region like the transparency resin represented with the acrylic resin like polymethylmethacrylate, a polycarbonate and the polycarbonate system resin like a polycarbonate polystyrene copolymer, epoxy system resin, etc., for example, glass, etc.

[0062] A light guide plate may be formed by the proper approach. As the manufacture approach more desirable than points, such as mass-production nature For example, the approach of filling up thru/or casting and carrying out polymerization of the liquefied resin which can carry out polymerization to the mold which can form predetermined prism-like irregularity with heat, ultraviolet rays thru/or a radiation, etc., Approaches, such as injection molding with which the metal mold which can fabricate the resin made to fluidize through the approach of pushing thermoplastics against the bottom of heating to the metal mold which can form predetermined prism-like irregularity, and imprinting a configuration, the thermoplastics which carried out heating melting, or heat and a solvent in a predetermined configuration is filled up, etc. are raised.

[0063] The light guide plate does not need to be formed as a like and may be formed as layered product of dissimilar material etc. and according to one sort of ingredients one-single layer material, although the sheet for prism-like concave convex formation was pasted up on the light guide section which bears transmission of light. In the above-mentioned light guide plate, the property of the angular distribution of outgoing radiation light, field internal division cloth, etc. can be adjusted based on control of the surface ratio of a shorter side side and a long side, the configuration of a tilt angle and a prism-like concave convex, curvature, etc.

[0064] Size of a light guide plate, magnitude of the light source, etc. by the purpose of use can determine the thickness of a light guide plate suitably. Especially the general thickness of the light guide plate in the case of using for a liquid crystal display etc. is 0.5-8mm 0.1-10mm above all 20mm or less based on the plane of incidence.

[0065] It can form suitably with a deposit metallurgy group vacuum evaporationo layer, a metallic foil metallurgy group vacuum evaporationo sheet, a plating sheet, etc., you may unite with the opposed face concerned of a light guide plate, and the reflecting layer 54 arranged to the opposed face of the outgoing radiation side of a light guide plate is piled up as a reflective sheet etc., and can take a proper arrangement gestalt in this invention. A metallic reflection side is more desirable than the point of reversing the circular polarization of light through reflection.

[0066] Moreover, when for example, detailed irregularity structure is given on the surface of a reflecting layer and it considers as the reflecting layer of an optical diffusion mold, it can also consider as the polarization light equipment of the gestalt which omitted the diffusion layer for diffusing the return light

which carried out total reflection through the base layer of a circular polarization of light detached core. In this case, the optical diffusion type concerned of reflecting layer can be made to serve as course modification by diffusion of said return light.

[0067] The light source of a light guide plate mold is formed by arranging the light source 52 usually like instantiation to drawing 5 at the plane of incidence of a light guide plate 51. Although a thing proper as the light source can be used, array objects, such as the shape of the point light source of the linear light source of a cathode-ray tube etc., light emitting diode, etc., its line, or a field, etc. can use preferably, for example (cold, heat). On the occasion of formation of the back light concerned, it can also consider as the combination object which has arranged proper auxiliary means, such as the light source holder 53 which surrounds the light source in order to lead the emission light from a linear light source to the side face of a light guide plate like the example of drawing if needed, and a prism sheet for the outgoing radiation directional control of light.

[0068] The light guide plate which can be preferably used for formation of polarization light equipment While the directivity is made to carry out outgoing radiation of the incident light from a side face from an outgoing radiation side at high effectiveness, and the outgoing radiation light excels [directivity] in high directivity and perpendicularity [as opposed to an outgoing radiation side above all] is shown Reflection repeats the re-incident light which it excelled in the re-outgoing radiation effectiveness of the re-incident light through a circular polarization of light detached core, and the directivity of the re-outgoing radiation light and an outgoing radiation include angle were as much as possible in agreement with the directivity of initial outgoing radiation light, and an outgoing radiation include angle, and minded the circular polarization of light detached core, and it is made to carry out outgoing radiation with a small reflective number of cycles above all that there is nothing.

[0069] The polarization light equipment by this invention prevents a reflective loss etc. as mentioned above by reusing the reflected light (re-incident light) by the circular polarization of light detached core as an outgoing radiation light by polarization conversion. While making a polarizing plate easy to change the outgoing radiation light into the optical condition which contains a linearly polarized light component richly through a quarter-wave length plate etc. if needed, and to penetrate and preventing an absorption loss A course change of a part of return light which carried out total reflection through the base layer of a circular polarization of light detached core is made by diffusion, from a circular polarization of light detached core, outgoing radiation is carried out again and improvement in efficiency for light utilization, especially improvement in transverse-plane brightness are aimed at.

[0070] Therefore, like the above, it can be excellent in the use effectiveness of light, and the polarization light equipment by this invention is bright, and it can excel in the perpendicularity of outgoing radiation light, and light with little light-and-darkness nonuniformity can be offered, and it can use it for various equipments preferably as a back light system in a liquid crystal display etc. from large-area-izing etc. being easy.

[0071] The liquid crystal display 6 which used the polarization light equipment 5 by this invention for the back light system at drawing 6 was illustrated. For 61, a liquid crystal cell and 62 are [an upper polarizing plate and 63] diffusion plates. A lower polarizing plate 4 and the lower diffusion plate 63 are formed if needed. A liquid crystal display is formed by generally assembling suitably component parts, such as a driving gear of accompanying in the liquid crystal cell and it which function as a liquid crystal shutter, a polarizing plate, a back light, and a phase contrast plate for compensation as occasion demands, etc. In this invention, except for the point using the above-mentioned polarization light equipment, there is especially no limitation and it can be formed according to the former. Especially, the liquid crystal display of a direct viewing type can be formed preferably.

[0072] Therefore, there is especially no limitation about the liquid crystal cell to be used, and a proper thing can be used. Although it is used in favor of what displays above all by carrying out incidence of the light of a polarization condition to a liquid crystal cell, for example, can use for the liquid crystal cell using a twist nematic liquid crystal or a super twist nematic liquid crystal etc. preferably, the liquid crystal and dichromatic dye of a non-twisting system can be used for the liquid crystal cell using the liquid crystal of

the guest host system distributed in liquid crystal, or a ferroelectric liquid crystal etc. There is especially no limitation also about the drive method of liquid crystal.

[0073] In addition, as a polarizing plate, as a polarizing plate by the side of a back light, as described above, the liquid crystal display using what has high degree of polarization is more desirable like the absorption mold linearly polarized light child of an iodine system or a color system etc. than especially the point of obtaining the display of the good contrast ratio by the incidence of the advanced linearly polarized light. On the occasion of formation of a liquid crystal display, proper optical layers, such as a diffusion plate formed, for example on the polarizing plate by the side of a check by looking, an anti glare layer, an antireflection film and a protective layer, a guard plate, or a phase contrast plate for compensation formed between a liquid crystal cell and a polarizing plate, can be arranged suitably.

[0074] The aforementioned phase contrast plate for compensation aims at compensating the wavelength dependency of a birefringence etc. and aiming at improvement in visibility etc. In this invention, it is arranged if needed between the polarizing plate by the side of a check by looking or/and a back light, and a liquid crystal cell etc. In addition, as a phase contrast plate for compensation, a proper thing can be used according to a wavelength region etc., and it may be formed as a superposition layer more than one layer or two-layer. The phase contrast plate for compensation can be obtained as an oriented film of instantiation etc. with the above-mentioned phase contrast plate for linearly polarized light conversion.

[0075] in this invention, laminating unification is carried out on the whole or partially, and the optical element thru/or components which forms the above-mentioned polarization light equipment and a liquid crystal display fixes -- having -- *** -- separation -- you may arrange in the easy condition.

[0076]

[Example]

The side-chain mold cholesteric-liquid-crystal polymer of four sorts of acrylic principal chains with which the example glass transition temperature of reference differs was heated and quenched to predetermined temperature after membrane formation (2 micrometers in thickness) by the spin coat method in the polyimide rubbing processing side of a triacetyl cellulose film with a thickness of 30 micrometers, the mirror plane-like selective reflection condition was presented, the left-handed circularly-polarized light was penetrated, and four sorts of cholesteric-liquid-crystal layers whose main wavelength of selective reflection is 470nm, 550nm, 640nm, or 770nm were obtained.

[0077] Between the base layers which the main wavelength of the selective reflection acquired in the example of example 1 reference becomes from the cholesteric-liquid-crystal layer which is 640nm, the main wavelength of selective reflection arranges and carried out the adhesion laminating of the cholesteric-liquid-crystal layer (470nm and 550nm), and the circular polarization of light division plate was obtained.

[0078] Next, the quarter-wave length plate whose transverse-plane phase contrast is 140nm was pasted up on the side near the cholesteric-liquid-crystal layer whose main wavelength of the selective reflection in the aforementioned circular polarization of light division plate is 550nm, the transparency shaft was made in agreement with a linearly polarized light side on the quarter-wave length plate, the polarizing plate was pasted up, and the optical element was obtained.

[0079] According to example 2 example 1, the circular polarization of light division plate which carried out the laminating of the cholesteric-liquid-crystal layer which is six layers whose main wavelength of selective reflection is 470nm, 550nm, 640nm, 470nm, 550nm, and 640nm one by one in the sequence concerned was obtained, and the optical element was obtained using it.

[0080] According to example 3 example 1, the circular polarization of light division plate which carried out the laminating of the cholesteric-liquid-crystal layer which is seven layers whose main wavelength of selective reflection is 470nm, 550nm, 640nm, 770nm, 470nm, 550nm, and 640nm one by one in the sequence concerned was obtained, and the optical element was obtained using it.

[0081] According to example of comparison 1 example 1, the circular polarization of light division plate which carried out the laminating of the cholesteric-liquid-crystal layer which is three layers whose main wavelength of selective reflection is 470nm, 550nm, and 640nm one by one in the sequence concerned

was obtained, and the optical element was obtained using it.

[0082] According to example of comparison 2 example 1, the circular polarization of light division plate which carried out the laminating of the cholesteric-liquid-crystal layer which is four layers whose main wavelength of selective reflection is 470nm, 550nm, 640nm, and 770nm one by one in the sequence concerned was obtained, and the optical element was obtained using it.

[0083] A cold cathode tube with a diameter of 3mm is arranged on the side face of the light guide plate in which detailed prism structure was formed on the evaluation trial inferior surface of tongue. A cold cathode tube is surrounded with the light source holder which consists of polyester film of silver vacuum evaporationo. On the top face of the surface light source equipment of the side light mold which comes to arrange the reflective sheet which becomes the inferior surface of tongue of a light guide plate from the polyester film of silver vacuum evaporationo The silica particle was contained, the front face turned the polarizing plate up, and has arranged [the diffusion sheet of detailed irregularity structure has been arranged,] the optical element obtained in the example and the example of a comparison on it, and polarization light equipment was obtained.

[0084] Next, the commercial TFT mold liquid crystal panel has been arranged on the top face of the polarizing plate in the aforementioned polarization light equipment, the liquid crystal display was obtained, and the transverse-plane brightness in the panel perpendicular direction at the time of back light lighting was investigated using the luminance meter (the TOPCON CORP. make, BM-5). The result was shown in degree table.

[0085]

	実施例 1	実施例 2	実施例 3	比較例 1	比較例 2
正面輝度(cd/m ²)	500	496	496	437	452

[Translation done.]

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CLAIMS

[Claim(s)]

[Claim 1] The circular polarization of light detached core characterized by having arranged the medium to which a polarization condition is changed between the base layers which a difference of the main wavelength of the reflected light becomes from a less than 20nm cholesteric-liquid-crystal layer.

[Claim 2] The circular polarization of light detached core which is that to which 80nm or more of main wavelength of the reflected light of the cholesteric-liquid-crystal layer is different from it of one [at least] base layer by the medium to which a polarization condition is changed consisting of a cholesteric-liquid-crystal layer more than one layer or two-layer in claim 1.

[Claim 3] The circular polarization of light detached core which has a cholesteric-liquid-crystal layer more than one layer to which 80nm or more of main wavelength of the reflected light is different from it of a base layer on the outside of the base layer of one side or both, or two-layer in claim 1 or 2.

[Claim 4] The circular polarization of light detached core which is that the cholesteric-liquid-crystal layer of arrangement indicates 1 / 2 wavelength plate functions to be to the slanting transmitted light in claim 2 or 3 between base layers.

[Claim 5] The optical element characterized by having a diffusion layer in one side of a circular polarization of light detached core according to claim 1 to 4.

[Claim 6] The optical element characterized by having a quarter-wave length plate in one side of a circular polarization of light detached core according to claim 1 to 4.

[Claim 7] The optical element which has the polarizing plate of dichromatic dye content to the quarter-wave length plate up side in claim 6.

[Claim 8] Polarization light equipment characterized by having a circular polarization of light detached core or an optical element according to claim 5 to 7 according to claim 1 to 4 above the light source which has a reflecting layer.

[Claim 9] The liquid crystal display characterized by having a liquid crystal cell above the circular polarization of light detached core in polarization light equipment according to claim 8.

[Translation done.]

NOTICES *

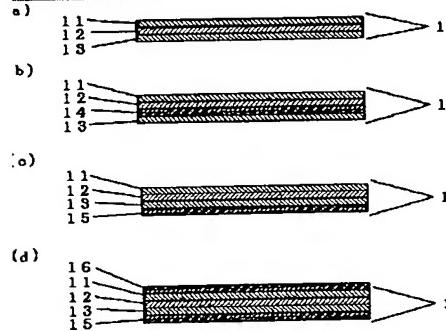
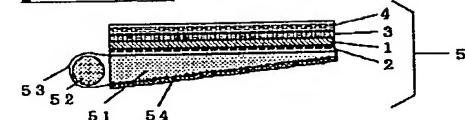
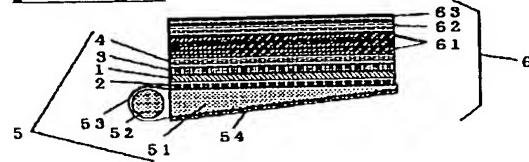
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DRAWINGS

[Drawing 1]**[Drawing 2]****[Drawing 3]****[Drawing 4]****[Drawing 5]****[Drawing 6]**

[Translation done.]

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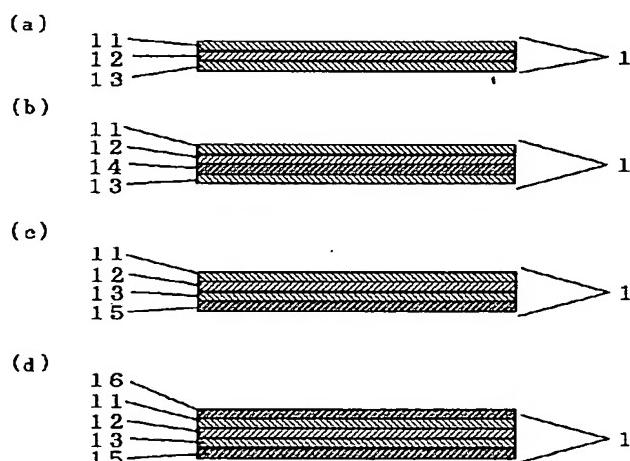
(54)【発明の名称】円偏光分離層、光学素子、偏光光源装置及び液晶表示装置

(57)【要約】

【課題】正面輝度に寄与する垂直入射光の透過円偏光特性を害することなく、斜め透過の楕円偏光を低減し、かつその楕円偏光を正面輝度の向上に寄与しうる光に変換できる円偏光分離層の開発。

【解決手段】反射光の中心波長の相違が20nm以内のコレステリック液晶層からなるベース層(11, 13)の間に、偏光状態を変化させる媒体(12, 14)を配置してなる円偏光分離層。

【効果】垂直入射光は重畠の各コレステリック液晶層を所定の円偏光として垂直透過し、一方のベース層を斜め透過した楕円偏光は他方のベース層で全反射され、その全反射光が再利用されて円偏光分離層より液晶表示装置等の良視認に有効な正面方向の光とし出射し、正面輝度が向上する。



【特許請求の範囲】

【請求項1】 反射光の中心波長の相違が20nm以内のコレステリック液晶層からなるベース層の間に、偏光状態を変化させる媒体を配置したことを特徴とする円偏光分離層。

【請求項2】 請求項1において、偏光状態を変化させる媒体が1層又は2層以上のコレステリック液晶層からなり、そのコレステリック液晶層の反射光の中心波長が、少なくとも一方のベース層のそれと80nm以上相違するものである円偏光分離層。

【請求項3】 請求項1又は2において、一方又は両方のベース層の外側に反射光の中心波長がベース層のそれと80nm以上相違する1層又は2層以上のコレステリック液晶層を有する円偏光分離層。

【請求項4】 請求項2又は3において、ベース層間に配置のコレステリック液晶層が斜め透過光に対し1/2波長板機能を示すものである円偏光分離層。

【請求項5】 請求項1～4に記載の円偏光分離層の一方に拡散層を有することを特徴とする光学素子。

【請求項6】 請求項1～4に記載の円偏光分離層の一方に1/4波長板を有することを特徴とする光学素子。

【請求項7】 請求項6において、1/4波長板の上側に、二色性染料含有の偏光板を有する光学素子。

【請求項8】 反射層を有する光源の上方に、請求項1～4に記載の円偏光分離層又は請求項5～7に記載の光学素子を有することを特徴とする偏光光源装置。

【請求項9】 請求項8に記載の偏光光源装置における円偏光分離層の上方に液晶セルを有することを特徴とする液晶表示装置。

【発明の詳細な説明】**【0001】**

【発明の技術分野】 本発明は、光利用効率に優れて高輝度の偏光光源装置や良視認の液晶表示装置を形成しうる円偏光分離層及びそれを用いた光学素子に関する。

【0002】

【背景技術】 従来、自然光を左右の円偏光に反射と透過を介して分離するコレステリック液晶層からなる円偏光分離層を用いた偏光光源が知られていた（特開昭59-127019号公報、特開昭61-122626号公報、特開昭63-121821号公報、特開平3-45906号公報、特開平6-324333号公報、特開平7-35925号公報、特開平7-36025号公報特開平7-36032号公報）。

【0003】 しかしながら、円偏光分離層に垂直（正面）入射した光は左右一方の円偏光として透過するものの、斜め入射した光は楕円偏光として透過し、これは1/4波長板を介しても円偏光の如く直線偏光とならずに楕円偏光状態を維持するため、偏光板に吸収される成分を含有して光利用効率に乏しい問題点があった。

【0004】 また円偏光分離層を斜め透過した楕円偏光

は、色変化を受けるため液晶表示装置等に適用した場合に視角変化による色変化として視認性を低下させる光となると共に、円偏光分離層より垂直出射して液晶表示装置等の良視認の確保に有効な正面輝度の向上に寄与しない問題点があった。

【0005】

【発明の技術的課題】 本発明は、正面輝度に寄与する垂直入射光の透過円偏光特性を害することなく、斜め透過の楕円偏光を低減し、かつその楕円偏光を正面輝度の向上に寄与しうる光に変換できる円偏光分離層の開発を課題とする。

【0006】

【課題の解決手段】 本発明は、反射光の中心波長の相違が20nm以内のコレステリック液晶層からなるベース層の間に、偏光状態を変化させる媒体を配置したことを特徴とする円偏光分離層を提供するものである。

【0007】

【発明の効果】 本発明によれば、垂直入射光は重畠の各コレステリック液晶層を所定の円偏光として垂直透過して正面輝度の向上に寄与する。一方、片側のベース層を斜め透過し、偏光状態を変化させる媒体に斜め入射した楕円偏光は、その媒体を透過することにより偏光特性の変換を受け、その一部の偏光の回転方向が逆転して次のベース層に斜め入射する際に全反射され、円偏光分離層の透過が遮られる。前記の結果、正面輝度に寄与する垂直入射光の透過円偏光特性を害することなく、液晶表示装置等に適用した場合に視角変化による色変化として視認性を低下させる斜め透過の楕円偏光を低減することができる。

【0008】 他方、前記で全反射された偏光は、戻り光として偏光状態を変化させる媒体を再透過する際に偏光特性が再度逆転して入射側のベース層を透過し、円偏光分離層より出射する。この出射光は、反射層を介し反射させて再度円偏光分離層に入射させ、その間に拡散層を介して拡散させることにより、その一部を円偏光分離層に垂直入射させて正面方向の光として取り出すことができる。その結果、一方のベース層を斜め透過した楕円偏光を他方のベース層による全反射で透過を繰りつつ、その全反射光を再利用して円偏光分離層より液晶表示装置等の良視認に有効な正面方向の光が得られ、正面輝度を向上させることができる。前記の結果、かかる円偏光分離層を用いて光利用効率に優れる、特に正面輝度に優れる偏光光源装置を形成することができ、また1/4波長板や偏光板等と組合せて明るくて視認性に優れる液晶表示装置を得ることができる。

【0009】

【発明の実施形態】 本発明の円偏光分離層は、反射光の中心波長の相違が20nm以内のコレステリック液晶層からなるベース層の間に、偏光状態を変化させる媒体を配置したものからなる。その例を図1(a)～(d)に示

した。1が円偏光分離層であり、11, 13がベース層、12, 14が偏光状態を変化させる媒体、15, 16が外側配置のコレステリック液晶層である。

【0010】コレステリック液晶層としては、グランジヤン配向により自然光を透過光と反射光として左右の円偏光に分離する適宜なものを用いよう。ちなみにその具体例としては、コレステリック液晶相を有する層、就中コレステリック相を呈する液晶ポリマーからなる層を有するシートや当該層をガラス板等の上に展開したシート、あるいはコレステリック相を呈する液晶ポリマーからなるフィルムなどがあげられる。従ってコレステリック液晶層は、必要に応じ支持基材上に支持された状態で重畠されていてもよい。

【0011】前記においてコレステリック液晶層は、可及的に均一に配向していることが好ましい。均一配向のコレステリック液晶層は、散乱のない反射光を提供して、液晶表示装置等の視野角の拡大に有利であり、特に斜め方向からも直接観察される直視型液晶表示装置等の形成に適している。

【0012】本発明による円偏光分離層は、反射光の中心波長の相違が20nm以内のコレステリック液晶層からなるベース層の間に、偏光状態を変化させる媒体を配置して重畠することにより形成することができる。これにより、一方のベース層を斜め透過した光の一部を他方のベース層を介して全反射させることができると。その全反射の達成性などの点より好ましいベース層における反射光の中心波長の相違は、15nm以内、就中10nm以内、特に5nm以内である。なお前記した反射光の中心波長の相違が20nmを超えると、全反射条件を満足するベース層関係を形成しにくくなり、斜め入射光が透過しやすくなる。

【0013】ベース層間に配置する、偏光状態を変化させる媒体としては、例えば1/4波長板や1/2波長板などの位相差板の如く偏光状態を変化させうる適宜なものを用いよう。就中、透過光の波長域を拡大する点などにより、コレステリック液晶層、特に反射光の中心波長が少なくとも一方のベース層のそれと80nm以上相違するコレステリック液晶層が好ましい。すなわち単層のコレステリック液晶層では通例、選択反射性（円偏光二色性）を示す波長域に限界があり、その限界は約100nmの波長域に及ぶ広い範囲の場合もあるが、その波長範囲でも液晶表示装置等に適用する場合に望まれる可視光の全域には及ばないから、選択反射性（反射波長域）の異なるコレステリック液晶層を重畠させて円偏光二色性を示す波長域を拡大させ、可視光域の全域ないし可及的に全域を反射波長域化する点よりコレステリック液晶層が好ましく用いよう。

【0014】ベース層間に配置する偏光状態を変化させる媒体は、1層又は2層以上であってよい。ベース層間に偏光状態を変化させる媒体として2層以上のコレステ

リック液晶層を配置する場合には、前記の点より反射波長域、就中、反射光の中心波長が異なるコレステリック液晶層の組合せとすることが好ましい。なおベース層間に、偏光状態を変化させる媒体以外の適宜な光透過層を配置してもよく、その光透過層は光学機能層であってもよい。

【0015】また偏光状態を変化させる媒体としては、一方のベース層を斜め透過した光の一部を他方のベース層を介して全反射させる点などより、斜め透過光に対し1/2波長板機能を示すものが好ましい。かかる1/2波長板機能は、ベース層間に配置する偏光状態を変化させる媒体の一部又は全体で達成されてよい。すなわち偏光状態を変化させる媒体が1層の場合には、その1層が1/2波長板機能を示すことが求められるが、偏光状態を変化させる媒体が2層以上の場合には、その1層又は2層以上がそれぞれ1/2波長板機能を示すものであってもよいし、2層以上の全体で1/2波長板機能を示すものであってもよい。

【0016】なお上記のコレステリック液晶層の重畠による反射波長域の拡大は、図1(c)、(d)に例示の如く、ベース層11、13の外側に反射光の中心波長がベース層のそれと80nm以上相違するコレステリック液晶層15、16を配置する方式にても達成することができる。その場合、コレステリック液晶層はベース層の一方又は両方に1層又は2層以上を重畠することができる。そしてこの場合にも、ベース層の一方又は両方に合計2層以上のコレステリック液晶層を重畠するときには、反射波長域、就中、反射光の中心波長が異なるものの組合せとすることが好ましい。

【0017】上記において、重畠するコレステリック液晶層は、各層で反射される円偏光の位相状態を揃えて各波長域で異なる偏光状態となることを防止し、利用できる状態の偏光を增量する点より、同じ方向の円偏光を反射するもの同士の組合せで用いることが好ましく、ベース層間では全反射を達成するために同じ方向の円偏光を反射するもの同士の組合せで用いることが必要である。またコレステリック液晶層は、一方のベース層を除き反射光の中心波長に基づいてその波長順序で重畠されていることが大視野角時の波長シフトを抑制する点などより好ましい。

【0018】コレステリック液晶には、適宜なものを用いてよく、特に限定はない。従って、液晶配向性を付与する共役性の直線状原子団（メソゲン）がポリマーの主鎖や側鎖に導入された主鎖型や側鎖型などの種々のものを用いよう。位相差の大きいコレステリック液晶分子ほど選択反射の波長域が広くなり、大視野角時の波長シフトに対する余裕などの点より好ましく用いよう。また重さや自立性等の点よりは液晶ポリマーが好ましく用いよう。さらに、その液晶ポリマーとしては、取扱い性や実用温度での配向の安定性などの点より、ガラス転移温度

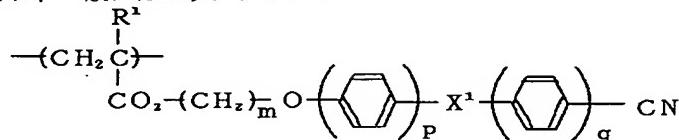
が30~150℃のものが好ましく用いられる。

【0019】ちなみに、前記した主鎖型の液晶ポリマーの例としては、屈曲性を付与するスペーサ部を必要に応じ介してパラ置換環状化合物等からなるメソゲン基を結合した構造を有する、例えばポリエステル系やポリアミド系、ポリカーボネート系やポリエステルイミド系などのポリマーがあげられる。

【0020】また側鎖型の液晶ポリマーの例としては、ポリアクリレートやポリメタクリレート、ポリシロキサンやポリマロネート等を主鎖骨格とし、側鎖として共役性の原子団からなるスペーサ部を必要に応じ介してパラ置換環状化合物等からなる低分子液晶化合物（メソゲン部）を有するもの、低分子カイラル剤含有のネマチック系液晶ポリマー、キラル成分導入の液晶ポリマー、ネマチック系とコレステリック系の混合液晶ポリマーなどがあげられる。

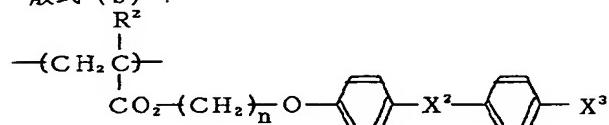
【0021】前記の如く、例えばアゾメチレン形やアゾ形、アゾキシ形やエステル形、ビフェニル形やフェニルシクロヘキサン形、ビシクロヘキサン形の如きパラ置換芳香族単位やパラ置換シクロヘキシル環単位などからなるネマチック配向性を付与するパラ置換環状化合物を有するものにても、不斉炭素を有する化合物等からなる適宜なキラル成分や低分子カイラル剤等を導入する方式などによりコレステリック配向性のものとすることができます（特開昭55-21479号公報、米国特許明細書第5332522号等）。なおパラ置換環状化合物におけるパラ位における末端置換基は、例えばシアノ基やアルキル基、アルコキシ基などの適宜なものであってよい。

【0022】またスペーサ部としては、屈曲性を示す例えばポリメチレン鎖- $(CH_2)_n$ -やポリオキシメチレン鎖- $(CH_2CH_2O)_m$ -などがあげられる。スペーサ部を形成する構造単位の繰返し数は、メソゲン部の化学構造等により適宜に決定され、一般にはポリメチレン*



（ただし、R¹は水素又はメチル基、mは1~6の整数、X¹はCO₂基又はOCO基であり、p及びqは1又は2で、かつp+q=3を満足する。）

一般式（b）：



（ただし、R²は水素又はメチル基、nは1~6の整

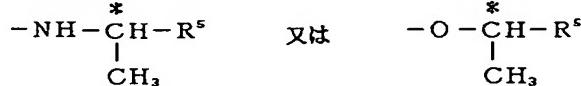
*鎖の場合にはnが0~20、就中2~12、ポリオキシメチレン鎖の場合にはmが0~10、就中1~3である。

【0023】なお上記した主鎖型液晶ポリマーの調製は例えば、成分モノマーをラジカル重合方式やカチオン重合方式やアニオン重合方式等により共重合させる、通例のポリマー合成に準じた適宜な方式で行うことができる。また側鎖型液晶ポリマーの調製も例えば、アクリル酸やメタクリル酸のエステルの如きビニル系主鎖形成用モノマーに必要に応じスペーサ基を介してメソゲン基を導入したモノマーをラジカル重合法等によりポリマー化するモノマー付加重合方式や、ポリオキシメチルシリレンのSi-H結合を介し白金系触媒の存在下にビニル置換メソゲンモノマーを付加反応させる方法、主鎖ポリマーに付与した官能基を介し相関移動触媒を用いたエステル化反応によりメソゲン基を導入する方法や、マロン酸の一部に必要に応じスペーサ基を介してメソゲン基を導入したモノマーとジオールとを重縮合反応させる方法などの適宜な方式で行うことができる。

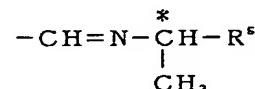
【0024】上記において、成膜性や良好なモノドメイン状態のグランジャン配向性、配向処理の短時間性やガラス状態への安定した固定性、コレステリック相の螺旋ピッチの制御性、薄くて軽くピッチ等の配向状態が実用温度で変化しにくく、耐久性や保存安定性に優れる円偏光分離層の形成性などの点より好ましく用いられる液晶ポリマーは、下記の一般式（a）で表わされるモノマー単位と、一般式（b）で表わされるモノマー単位を成分とする共重合体、就中、一般式（a）のモノマー単位60~95重量%と、一般式（b）のモノマー単位40~5重量%からなる共重合体を成分とするものである（特願平7-251818号）。

【0025】一般式（a）：

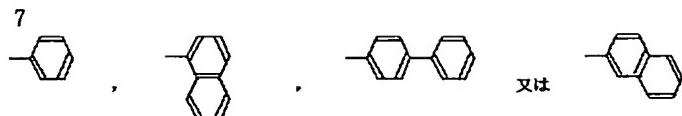
数、X²はCO₂基又はOCO基、X³は-CO-R³又は-R⁴であり、そのR³は



R⁴は



であり、R⁵は下記のものである。）



【0026】前記の一般式(a)、一般式(b)で表わされるモノマー単位を形成しうるアクリル系モノマーは、適宜な方法で合成することができる。その例としては、先ずエチレンクロロヒドリンと4-ヒドロキシ安息香酸を、ヨウ化カリウムを触媒としてアルカリ水溶液中で加熱還流させてヒドロキシカルボン酸を得た後、それをアクリル酸又はメタクリル酸と脱水反応させて(メタ)アクリレートとし、その(メタ)アクリレートを4-シアノ-4'-ヒドロキシビフェニルでDCC(ジシクロヘキシカルボジイミド)とDMA P(ジメチルアミノピリジン)の存在下にエステル化することにより一般式(a)に属するモノマーを得る方法があげられる。

【0027】また、一般式(b)に属するアクリル系モノマーの合成例としては、先ずヒドロキシアルキルハライドと4-ヒドロキシ安息香酸を、ヨウ化カリウムを触媒としてアルカリ水溶液中で加熱還流させてヒドロキシカルボン酸を得た後、それをアクリル酸又はメタクリル酸と脱水反応させて(メタ)アクリレートとしその(メタ)アクリレートを、4位にR³基含有のCO基を有するフェノールでDCCとDMA Pの存在下にエステル化する方法や、前記の脱水反応後その(メタ)アクリレートを4位に不齊炭素基を有するフェノールでDCCとDMA Pの存在下にエステル化する方法などがあげられる。

【0028】従って、前記の一般式(a)や一般式(b)に属する他のモノマーも、目的の導入基を有する適宜な原料を用いて上記に準じて合成することができる。なお前記の4位にR³基含有のCO基を有するフェノールは、例えば先ずクロロ蟻酸メチルと4-ヒドロキシ安息香酸をアルカリ水溶液中で反応させてカルボン酸とし、それをオキサリルクロリドで酸クロライトとした後、ピリジン/テトラヒドロフラン中でH-R³と反応させてR³基を導入し、ついでそれをアンモニア水で処理して保護基を除去する方法などにより、また4位に不齊炭素基を有するフェノールは、例えば4-ヒドロキシベンズアルデヒドと(S)-(-)-1-フェニルエチルアミンをトルエン中で共沸脱水する方法などにより得ることができる。

【0029】上記した共重合体は、その一般式(b)で表わされるモノマー単位の含有率を変えることでコレステリック液晶の螺旋ピッチを変化させることができる。従って、一般式(b)で表わされるモノマー単位の含有率の制御で円偏光二色性を示す波長を調節でき、可視光域の光に対して円偏光二色性を示す光学素子も容易に得ることができる。

【0030】液晶ポリマーによるコレステリック液晶層の形成は、従来の配向処理に準じた方法で行うことがで

きる。ちなみにその例としては、支持基材上にポリイミドやポリビニルアルコール、ポリエステルやポリアリレート、ポリアミドイミドやポリエーテルイミド等の膜を形成してレーヨン布等でラビング処理した配向膜、又はSiOの斜方蒸着層、又は延伸処理による配向膜等からなる適宜な配向膜の上に液晶ポリマーを開展してガラス転移温度以上、等方相転移温度未満に加熱し、液晶ポリマー分子がグランジヤン配向した状態でガラス転移温度未満に冷却してガラス状態とし、当該配向が固定化された固化層を形成する方法などがあげられる。

【0031】前記の支持基材としては、例えばトリアセチルセルロースやポリビニルアルコール、ポリイミドやポリアリレート、ポリエステルやポリカーボネート、ポリスルホンやポリエーテルスルホン、アモルファスポリオレフィンや変性アクリル系ポリマー、エポキシ系樹脂の如きプラスチックからなる単層又は積層フィルム、あるいはガラス板などの適宜なものを用いる。薄型化等の点よりは、プラスチックフィルムが好ましく、また偏光状態の変化の防止による光の利用効率の向上などの点よりは複屈折による位相差が可及的に小さいものが好ましい。

【0032】液晶ポリマーの展開は、例えば液晶ポリマーの溶媒による溶液をスピンドルコート法やロールコート法、フローコート法やプリント法、ディップコート法や流延成膜法、バーコート法やグラビア印刷法等の適宜な方法で薄層展開し、それを必要に応じ乾燥処理する方法などにより行うことができる。前記の溶媒としては、例えば塩化メチレンやシクロヘキサン、トリクロロエチレンやテトラクロロエタン、N-メチルピロリドンやテトラヒドロフランなどの適宜なものを用いる。

【0033】また液晶ポリマーの加熱溶融物、好ましくは等方相を呈する状態の加熱溶融物を前記に準じ展開し、必要に応じその溶融温度を維持しつつ更に薄層に展開して固化させる方法などの、溶媒を使用しない方法、従って作業環境の衛生性等が良好な方法によつても液晶ポリマーを展開させることができる。なお液晶ポリマーの展開に際しては、薄型化等を目的に必要に応じて配向膜を介したコレステリック液晶層の重疊方式なども採ることができる。

【0034】液晶ポリマーの展開層を配向させるための加熱処理は、上記した如く液晶ポリマーのガラス転移温度から等方相転移温度までの温度範囲、すなわち液晶ポリマーが液晶相を呈する温度範囲に加熱することにより行うことができる。また配向状態の固定化は、ガラス転移温度未満に冷却することで行うことができ、その冷却条件については特に限定はない。通例、前記の加熱処理を300℃以下の温度で行なうことから、自然冷却方

式が一般に採られる。

【0035】支持基材上に形成した液晶ポリマーの固化層は、支持基材との一体物としてそのまま円偏光分離層に用いうるし、支持基材より剥離してフィルム等からなる円偏光分離層として用いることもできる。フィルム等からなる支持基材との一体物として形成する場合には、偏光の状態変化の防止性などの点より、位相差が可及的に小さい支持基材を用いることが好ましい。

【0036】コレステリック液晶層の厚さは、配向の乱れや透過率低下の防止、選択反射の波長範囲（反射波長域）の広さなどの点より、0.5～50μm、就中1～30μm、特に1.5～10μmが好ましい。また円偏光分離層の薄型化等の点より2層のコレステリック液晶層の合計厚が1～50μm、就中2～30μm、特に3～10μmであることが好ましい。さらに支持基材を有する場合には、その基材を含めた合計厚が20～200μm、就中25～150μm、特に30～100μmであることが好ましい。円偏光分離層の形成に際しては、コレステリック液晶層に安定剤や可塑剤、あるいは金属類などからなる種々の添加剤を必要に応じて配合することができる。

【0037】本発明において用いる円偏光分離層は、例えば低分子量体からなるコレステリック液晶層をガラスやフィルム等の透明基材で挿持したセル形態、液晶ポリマーからなるコレステリック液晶層を透明基材で支持した形態、コレステリック液晶層の液晶ポリマーフィルムからなる形態、それらの形態物を適宜な組合せで重畠した形態などの適宜な形態とすることができます。

【0038】前記の場合、コレステリック液晶層をその強度や操作性などに応じて1層又は2層以上の支持基材で保持することもできる。2層以上の支持基材を用いる場合には、偏光の状態変化を防止する点などより例えば無配向のフィルムや、配向しても複屈折の小さいトリアセテートフィルムなどの如く位相差が可及的に小さいものが好ましく用いうる。薄型化等の点より好ましい形態は、透明基材で支持した形態や液晶ポリマーのフィルムからなる形態などである。

【0039】本発明による円偏光分離層は、ベース層となるコレステリック液晶層を反射光の中心波長が異なる組合せで2対以上含む状態に形成することもできる。なおコレステリック液晶層の重畠には、製造効率や薄膜化などの点より液晶ポリマーの使用が特に有利である。重畠処理は、単なる重ね置きや、粘着剤等の接着剤を介した接着などの適宜な方式を探ることができる。

【0040】本発明においては、円偏光分離層に対して拡散層や1/4波長板や偏光板等の適宜な光学層の1種又は2種以上を配置して種々の光学素子を形成することができる。その例を図2、図3、図4に示した。2が拡散層、3が1/4波長板、4が偏光板である。

【0041】拡散層は、上記したように斜め入射光を円

偏光分離層のベース層で全反射させてなる戻り光の進路変更を目的とし、この場合には円偏光分離層の光源光入射側に設けられる。拡散層は、例えば粒子分散樹脂層の形成方式、サンドブラストや化学エッティング等の表面凹凸化処理による方式、機械的ストレスや溶剤処理等によるクレイズ発生方式、所定の拡散構造を設けた金型による転写形成方式などの任意な方式で、円偏光分離層への塗布層や拡散シートなどとして適宜に形成することができる。

【0042】また拡散層は、光学素子からの出射光を平準化して明暗ムラを抑制し、液晶セルに適用した場合に画素との干渉でモアレによるギラギラした視認が生じることの防止などを目的に配置することもできる。この場合には、円偏光分離層の1/4波長板付設側やそれに設けた1/4波長板や偏光板の間、あるいは偏光板の上面などの、円偏光分離層や1/4波長板や偏光板等に隣接した適宜な位置に1層又は2層以上を配置することができる。円偏光分離層より出射した光の偏光状態の維持性などの点より好ましく用いうる拡散層は、位相差が波長633nmの垂直入射光、好ましくは入射角30度以内の入射光に基づいて30nm以下、就中0～20nmのものである。

【0043】1/4波長板は、直線偏光変換手段として機能するものであり、円偏光分離層より出射した円偏光が1/4波長板に入射して位相変化を受け、その位相変化が1/4波長に相当する波長の光は直線偏光に変換され、他の波長光は梢円偏光に変換される。変換された梢円偏光は、前記の直線偏光に変換された光の波長に近いほど扁平な梢円偏光となる。かかる結果、偏光板を透過しうる直線偏光成分を多く含む状態の光が1/4波長板より出射されることとなる。

【0044】従って図例の如く1/4波長板3は、円偏光分離層1の光出射側に配置される。なおコレステリック液晶層が一方のベース層を除き反射光の中心波長の順序で重畠されている場合には、上記した波長シフトの抑制などの点よりその長波長のコレステリック液晶層側を光出射側とすることが好ましい。前記の如く1/4波長板を介して直線偏光成分の多い状態に変換することにより、偏光板を透過しやすい光とができる。

【0045】すなわち前記において、偏光板を用いずに、円偏光分離層よりの出射偏光をそのまま液晶セルに入射させて表示を達成することは可能であるが、偏光板を介することで前記した表示品位の向上等をはかりうることから必要に応じて偏光板が用いられる。その場合に、偏光板に対する透過率の高いほど表示の明るさの点

より有利であり、その透過率は偏光板の偏光軸（透過軸）と一致する偏光方向の直線偏光成分を多く含むほど高くなるので、それを目的に直線偏光変換手段を介して円偏光分離層よりの出射偏光を所定の直線偏光に変換するものである。

【0046】 $1/4$ 波長板としては、円偏光分離層より出射した円偏光を、 $1/4$ 波長の位相差に相当して直線偏光を多く形成しうると共に、他の波長の光を前記直線偏光と可及的にパラレルな方向に長径方向を有し、かつ可及的に直線偏光に近い扁平な橢円偏光に変換しうるものが好ましい。かかる $1/4$ 波長板を用いることにより、その出射光の直線偏光方向や橢円偏光の長径方向が偏光板の透過軸と可及的に平行になるように配置して、偏光板を透過しうる直線偏光成分の多い状態の光を得ることができる。

【0047】 $1/4$ 波長板は、1層又は2層以上の位相差板の重疊層として形成することができる。1層の位相差板からなる $1/4$ 波長板の場合には、複屈折の波長分散が小さいものほど波長毎の偏光状態の均一化をはかることができて好ましい。一方、位相差板の重疊化は、波長域における波長特性の改良に有効であり、その組合せは波長域などに応じて適宜に決定してよい。

【0048】ちなみに可視光域の光に対し波長範囲や変換効率等の点より好ましく用いられる単層型の $1/4$ 波長板としては、その位相差が小さいもの、就中 $100\sim180\text{nm}$ 、特に $110\sim150\text{nm}$ 以下の位相差を与えるものである。また2層以上の位相差板からなる $1/4$ 波長板とする場合には、 $100\sim180\text{nm}$ の位相差を与える層を1層以上の奇数層で含む、 200nm 以上の位相差を与える層との組合せとすることが波長特性等の点より好ましい。

【0049】 $1/4$ 波長板を形成する位相差板は、適宜な材質で形成でき、透明で均一な位相差を与えるものが好ましい。一般には、例えばポリカーボネートやポリスルホン、ポリエステルやポリメチルメタクリレート、ポリアミドやポリビニールアルコール等の適宜なプラスチックからなるフィルムを延伸処理してなる複屈折性フィルムなどが用いられる。

【0050】上記の図4に例示の如く $1/4$ 波長板3の上には必要に応じて偏光板4を設けることができる。かかる形態の光学素子は、その偏光板を液晶セルの光源側の偏光板として利用することができる。また偏光板は、円偏光分離層に $1/4$ 波長板を介すことなく配置してもよく、この場合には円偏光分離層を透過した円偏光を偏光板を介し直接直線偏光化する。

【0051】偏光板としては、適宜なものを用いられるが一般には、偏光フィルムからなるものが用いられる。偏光フィルムの例としては、ポリビニルアルコール系や部分ホルマール化ポリビニルアルコール系、エチレン・酢酸ビニル共重合体系部分ケン化物の如き親水性高分子の

フィルムにヨウ素等の二色性染料を吸着させて延伸したもの、ポリビニルアルコールの脱水処理物やポリ塩化ビニルの脱塩酸処理物の如きポリエン配向フィルムなどがあげられる。

【0052】円偏光分離層に付設する偏光板としては、二色性染料を含有するタイプのものが偏光度等の点より特に好ましく用いられる。偏光フィルムの厚さは通例 $5\sim80\mu\text{m}$ であるが、これに限定されない。用いる偏光板は、偏光フィルムの片面又は両面を透明保護層等で被覆したものなどであってもよい。

【0053】本発明による円偏光分離層や光学素子は、偏光光源装置の形成に好ましく用いられる。偏光光源装置の形成は、光源の上に円偏光分離層や光学素子を配置することにより行うことができる。なお図2の如く外表面に拡散層2を有する光学素子の場合にはその拡散層側に光源が配置され、図3や図4の如く円偏光分離層が $1/4$ 波長板3等を有する場合には、その $1/4$ 波長板等を有しない側に光源が配置される。

【0054】図5に偏光光源装置5の例を示した。これは、円偏光分離層を光学素子として用いた場合を示しており、51が導光板、52が光源である。導光板51は、側面に配置した光源52からの入射光を上面（円偏光分離層側）より出射して光源52と一体的に機能し、円偏光分離層に対して光を供給する光源として機能するものである。

【0055】前記の偏光光源装置5によれば、光源52からの入射光が導光板51の上面より出射し、その垂直方向の光は、出射面側に配置した円偏光分離層1に入射して左右一方の円偏光が透過し、他方の円偏光が反射されて戻り光として導光板51に再入射する。導光板に再入射した光は、下面の反射層54で反射されて再び円偏光分離層1に入射し、透過光と反射光（再々入射光）に再度分離される。

【0056】一方、円偏光分離層1に斜め入射して上記したベース層で全反射された戻り光も、導光板下面の反射層54に入射して反射され、再び拡散層2を介して円偏光分離層1に入射する。その場合、再入射光の一部は拡散層2を介した拡散で円偏光分離層に垂直入射しうる光に変換され、前記した垂直方向の光と同様に挙動する。残る光は、再び斜め入射光として挙動する。従って斜め入射光の戻り光の内、拡散で円偏光分離層に垂直入射しうる光に変換される割合が多いほど正面輝度を向上させることができる。

【0057】上記のように偏光光源装置における光源としては、光利用効率の向上などの点より、側面に配置した光源からの入射光を上下面の一方より出射する導光板型のものが好ましく用いられる。その導光板としては、適宜なものを用いられるが一般には、いずれか一方が出射面となる上下面、及び上下面間の少なくとも一側面からなる入射面を有する板状物からなるものが用いられる。

【0058】導光板の形態は、出射面よりの出射効率に優れその出射光が出射面に対する垂直性に優れて有効利用しやすく、また円偏光分離層を介した再入射光の出射効率にも優れてその出射方向の初期出射方向との近似性などの点より、微細なプリズム状凹凸、就中、長辺面と短辺面からなる凸部又は凹部を周期的に有する構造が好ましい（特願平7-321036号）。さらに入射面に對向する側端部の厚さが入射面のそれよりも薄いもの、就中50%以下の厚さであるものが好ましい。

【0059】前記の入射面に対する対向側端部の薄型化は、入射面より入射した光が伝送端としての当該対向側端部に至るまでに、プリズム状凹凸面の短辺面に効率よく入射し、その反射を介し出射面より出射して入射光を目的面に効率よく供給できる点で有利である。またかかる薄型化構造とすることで導光板を軽量化でき、例えばプリズム状凹凸面が直線状の場合、均一厚の導光板の約75%の重量とすることができる。

【0060】プリズム状凹凸面における凸部又は凹部のピッチは、出射光がその凸部又は凹部を介し通例ストライプ状に放出されるため明暗ムラの抑制や液晶セルとのモアレの防止などの点より小さいほど好ましい。製造精度等を考慮した好ましい凸部又は凹部の周期は、500μm以下、就中300μm以下、特に5～200μmである。

【0061】導光板は、光源の波長領域に応じそれに透明性を示す適宜な材料にて形成しうる。ちなみに可視光域では、例えばポリメチルメタクリレートの如きアクリル系樹脂、ポリカーボネートやポリカーボネート・ポリスチレン共重合体の如きポリカーボネート系樹脂、エポキシ系樹脂等で代表される透明樹脂やガラスなどの如く約400～700nmの波長範囲で透明性を示すものがあげられる。

【0062】導光板は、適宜な方法で形成したものであってよい。量産性等の点より好ましい製造方法としては、例えば熱や紫外線ないし放射線等で重合処理しうる液状樹脂を、所定のプリズム状凹凸を形成しうる型に充填ないし流延して重合処理する方法や、熱可塑性樹脂を所定のプリズム状凹凸を形成しうる金型に加熱下に押付けて形状を転写する方法、加熱溶融させた熱可塑性樹脂あるいは熱や溶媒を介して流動化させた樹脂を所定の形状に成形しうる金型に充填する射出成形等の方法などがあげられる。

【0063】導光板は、例えば光の伝送を担う導光部にプリズム状凹凸面形成用のシートを接着したものなく、異種材料の積層体などとして形成されていてもよく、1種の材料による一体的単層物として形成されていい必要はない。上記した導光板では、短辺面と長辺面の面積比や傾斜角、プリズム状凹凸面の形状や曲率等の制御に基づいて出射光の角度分布や面内分布等の特性を調節することができる。

【0064】導光板の厚さは、使用目的による導光板のサイズや光源の大きさなどにより適宜に決定することができる。液晶表示装置等に用いる場合の導光板の一般的な厚さは、その入射面に基づき20mm以下、就中0.1～10mm、特に0.5～8mmである。

【0065】導光板の出射面の対向面に配置する反射層54は、メッキ層や金属蒸着層、金属箔や金属蒸着シート、メッキシートなどにより適宜に形成でき、導光板の当該対向面に一体化されていてもよいし、反射シート等として重ね合されていてもよく、本発明にては適宜な配置形態を探ることができる。反射を介して円偏光を反転させる点よりは金属反射面が好ましい。

【0066】また反射層の表面に例えば微細凹凸構造を付与するなどして光拡散型の反射層とした場合には、円偏光分離層のベース層を介して全反射させた戻り光を拡散させるための拡散層を省略した形態の偏光光源装置とすることもできる。この場合には、当該光拡散型の反射層に前記戻り光の拡散による進路変更を兼ねさせることができる。

【0067】導光板型の光源は、図5に例示の如く通常、導光板51の入射面に光源52を配置することにより形成される。その光源としては適宜なものを用いうるが、例えば（冷、熱）陰極管等の線状光源や発光ダイオード等の点光源、あるいはその線状又は面状等のアレイ体などが好ましく用いうる。当該バックライトの形成に際しては、必要に応じて図例の如く、線状光源からの発散光を導光板の側面に導くために光源を包囲する光源ホルダ53や、光の出射方向制御用のプリズムシートなどの適宜な補助手段を配置した組合せ体とすることもできる。

【0068】偏光光源装置の形成に好ましく用いうる導光板は、側面よりの入射光を高い効率で出射面より出射させ、その出射光が高い指向性、就中、出射面に対する垂直性に優れる指向性を示すと共に、円偏光分離層を介した再入射光の再出射効率に優れ、その再出射光の指向性と出射角度が初期出射光の指向性と出射角度に可及的に一致し、かつ円偏光分離層を介した再入射光を少ない反射繰返し数で、就中、反射の繰返しなく出射するようにしたものである。

【0069】上記のように本発明による偏光光源装置は、円偏光分離層による反射光（再入射光）を偏光変換による出射光として再利用することで反射ロス等を防止し、その出射光を必要に応じ1/4波長板等を介し直線偏光成分をリッチに含む光状態に変換して偏光板を透過しやすくし吸収ロスを防止すると共に、円偏光分離層のベース層を介して全反射させた戻り光の一部を拡散により進路変更させて円偏光分離層より再度出射させて光利用効率の向上、特に正面輝度の向上を図るようにしたものである。

【0070】従って本発明による偏光光源装置は、上記

の如く光の利用効率に優れて明るく、出射光の垂直性に優れて明暗ムラの少ない光を提供し、大面積化等も容易であることより液晶表示装置等におけるバックライトシステムなどとして種々の装置に好ましく用いることができる。

【0071】図6に本発明による偏光光源装置5をバックライトシステムに用いた液晶表示装置6を例示した。61が液晶セル、62が上側の偏光板、63が拡散板である。下側の偏光板4や拡散板63は必要に応じて設けられる。液晶表示装置は一般に、液晶シャッタとして機能する液晶セルとそれに付随する駆動装置、偏光板、バックライト、及び必要に応じての補償用位相差板等の構成部品を適宜に組立てることなどにより形成される。本発明においては、上記した偏光光源装置を用いる点を除いて特に限定ではなく、従来に準じて形成することができる。特に、直視型の液晶表示装置を好ましく形成することができる。

【0072】従って用いる液晶セルについては特に限定ではなく、適宜なものを用いよう。就中、偏光状態の光を液晶セルに入射させて表示を行うものに有利に用いられ、例えばツイストネマチック液晶やスーパーツイストネマチック液晶を用いた液晶セル等に好ましく用いだが、非ツイスト系の液晶や二色性染料を液晶中に分散させたゲストホスト系の液晶、あるいは強誘電性液晶を用いた液晶セルなどにも用いよう。液晶の駆動方式についても特に限定はない。

【0073】なお高度な直線偏光の入射による良好なコントラスト比の表示を得る点よりは偏光板として、特にバックライト側の偏光板として、上記した如く例えばヨウ素系や染料系の吸収型直線偏光子などの如く偏光度の高いものを用いた液晶表示装置が好ましい。液晶表示装置の形成に際しては、例えば視認側の偏光板の上に設ける拡散板やアンチグレア層、反射防止膜や保護層や保護板、あるいは液晶セルと偏光板の間に設ける補償用位相差板などの適宜な光学層を適宜に配置することができる。

【0074】前記の補償用位相差板は、複屈折の波長依存性などを補償して視認性の向上等をはかることを目的とするものである。本発明においては、視認側又は/及びバックライト側の偏光板と液晶セルの間等に必要に応じて配置される。なお補償用位相差板としては、波長域などに応じて適宜なものを用いることができ、1層又は2層以上の重疊層として形成されていてよい。補償用位相差板は、上記した直線偏光変換用の位相差板で例示の延伸フィルムなどとして得ることができる。

【0075】本発明において、上記した偏光光源装置や液晶表示装置を形成する光学素子ないし部品は、全体的に部分的に積層一体化されて固着されていてもよいし、分離容易な状態に配置したものであってもよい。

【0076】

【実施例】

参考例

ガラス転移温度が異なる4種のアクリル系主鎖の側鎖型コレステリック液晶ポリマーを、厚さ30μmのトリアセチルセルロースフィルムのポリイミドラビング処理面にスピンドルコート方式で成膜後(厚さ2μm)、所定温度に加熱して急冷し、鏡面状の選択反射状態を呈して左円偏光を透過し、選択反射の中心波長が470nm、550nm、640nm又は770nmである4種のコレステリック液晶層を得た。

【0077】実施例1

参考例で得た選択反射の中心波長が640nmのコレステリック液晶層からなるベース層の間に、選択反射の中心波長が470nmと550nmのコレステリック液晶層を配置して接着積層し、円偏光分離板を得た。

【0078】次に、前記の円偏光分離板における選択反射の中心波長が550nmのコレステリック液晶層に近い側に、正面位相差が140nmの1/4波長板を接着し、その1/4波長板の上に直線偏光面に透過軸を一致させて偏光板を接着し、光学素子を得た。

【0079】実施例2

実施例1に準じて、選択反射の中心波長が470nm、550nm、640nm、470nm、550nm、640nmの6層のコレステリック液晶層を当該順序で順次積層した円偏光分離板を得、それを用いて光学素子を得た。

【0080】実施例3

実施例1に準じて、選択反射の中心波長が470nm、550nm、640nm、770nm、470nm、550nm、640nmの7層のコレステリック液晶層を当該順序で順次積層した円偏光分離板を得、それを用いて光学素子を得た。

【0081】比較例1

実施例1に準じて、選択反射の中心波長が470nm、550nm、640nmの3層のコレステリック液晶層を当該順序で順次積層した円偏光分離板を得、それを用いて光学素子を得た。

【0082】比較例2

実施例1に準じて、選択反射の中心波長が470nm、550nm、640nm、770nmの4層のコレステリック液晶層を当該順序で順次積層した円偏光分離板を得、それを用いて光学素子を得た。

【0083】評価試験

下面に微細プリズム構造を形成した導光板の側面に直径3mmの冷陰極管を配置し、銀蒸着のポリエチルフィルムからなる光源ホルダにて冷陰極管を包囲し、導光板の下面に銀蒸着のポリエチルフィルムからなる反射シートを配置してなるサイドライト型の面光源装置の上面に、シリカ粒子を含有して表面が微細凹凸構造の拡散シートを配置し、その上に実施例、比較例で得た光学素子をその偏光板を上側にして配置し、偏光光源装置を得

た。

【0084】次に、前記の偏光光源装置における偏光板の上面に、市販のTFT型液晶パネルを配置して液晶表示装置を得、輝度計（トプコン社製、BM-5）を用い＊

*でバックライト点灯時のパネル垂直方向における正面輝度を調べた。結果を次表に示した。

【0085】

	実施例1	実施例2	実施例3	比較例1	比較例2
正面輝度(cd/m ²)	500	496	496	437	452

【図面の簡単な説明】

【図1】円偏光分離層例の断面図

【図2】光学素子例の断面図

【図3】他の光学素子例の断面図

【図4】さらに他の光学素子例の断面図

【図5】偏光光源装置例の断面図

【図6】液晶表示装置例の断面図

【符号の説明】

1：円偏光分離層

11, 13:コレステリック液晶層からなるベース層 ※

10※12, 14:偏光状態を変化させる媒体

15, 16:コレステリック液晶層からなる外部配置層

2:拡散層

3:1/4波長板

4:偏光板

5:偏光光源装置

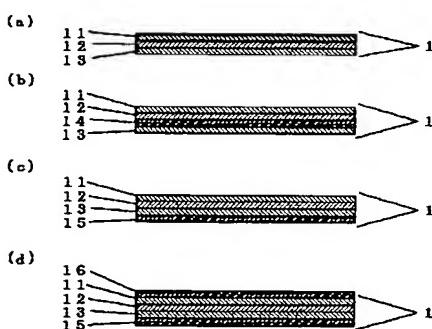
51:導光板

52:光源

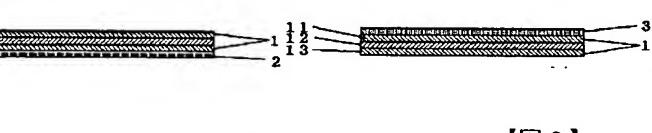
54:反射層

6:液晶表示装置

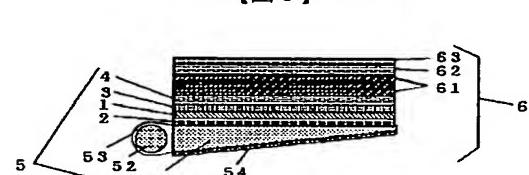
【図1】



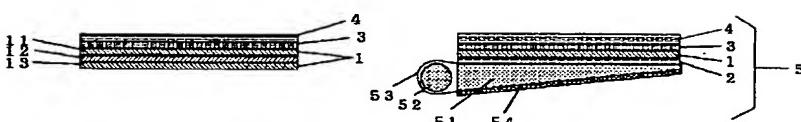
【図2】



【図3】



【図4】



【図5】

【図6】

